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A COLLECTION OF SELECTED PAPERS FROM THE THIRD ALL-CHINA ELECTROEMISSIONS TECHNOLOGY CONFERENCE 1990.5.21-25

(Selected Pages)

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V. Meeting Agenda:

Opening Ceremony (May 22d, Tuesday 8:30 A.M. Meeting Hall)

A Electroemission Microtechnology

May 22d A.M., Meeting Hall

Sponsors: Zhang Zhaoxiang , Bai Chunli

B Electroemission Electron Sources and Vacuum Microelectronics Technology

May 22d P.M. Meeting Hall

Sponsors: Liu Guangyi Xie Xinneng

C The Theory and Calculation of Electroemissions

May 23d A.M. Hall No.2
Sponsors: Tang Tiantong and Liu Yun(unclear)

D Research on the Microstructure of Materials

May 23d A.M. Meeting Hall

Sponsors: Ren Dagang Ren Duomin

E Surface Properties and Thin Membranes

May 24th A.M. Meeting Hall

Sponsors: Liu Wu and Li Guohe

F Electroemissions and Flat Plate Display Screens

May 24th A.M. Hall No.2

Sponsors: Chen Guoping and Wei Chun (unclear)

G Test Manufacture of Component Parts for Electroemission Equipment

May 24th P.M. Meeting Hall

Sponsors: Chen Ergang and Li Wu

Experimental Research on the Characteristics of Ta Field Emissions

Yang Deqing Wang Yong Chen Ergang

(Physics Department of Yunnan University)

At the present time, in field emission electron guns, one generally opts in all cases for the use of metallic Tungsten (W) in order to manufacture emission point terminals. Although these types of point terminals are quite effective, their demands on system vacuum, however, are severe. They require the attaining of $5x10^{-9}$ atmospheres or more. If this cannot be done, then, the point terminal electronic emissions will be unstable. Their useful lives also will be severely affected. For many years, on the foundation of research into single crystal W (111) and multiple crystal W electroemission characteristics, we have also carried out systematic investigations into the electroemission characteristics of metallic Tantalum (Ta). In comparisons of experiments with these two materials, we discovered that there are areas of similarity between the electroemission characteristics of Ta and those of W. However, each has its own peculiar characteristics

(1) Ta, in a similar fashion to W, is capable of using electrolytic corrosion methods for the manufacturing of radii of curvature which are between several hundred and several thousand A^{O}--suitable for the field emission requirements of point terminals.

(2) Measurements of field emission current flows for Ta are measured by voltage or electrical potential relationships, and, like W, it satisfies F-N theory (unclear). However, under the same conditions, the field emission current flows for Ta must be larger than those for W. The reason for this is that the Ta work function (4.13 electron volts) is smaller than that for W (4.52 electron volts).

(3) In an environment where there is a vacuum of $10^{-5} \sim 10^{-6}$ atmospheres, normally, for Tungsten, it is difficult to see the occurence of or make observations of field emissions. However, this is not the case with Ta. Not only is it possible to continuously carry out field effect electron emissions. Moreover, it is also possible to continuously observe the form or contour of the Ta field emissions. It is only when the emissions are unstable that the contour is disrupted and lost.

(4) Under conditions in which there is a vacuum of 5×10^{-8} atmospheres, the field emissions of Ta are capable of achieving a beam current of 6 microamperes. The degree of stability showed results such that, every 10 (unclear) minutes, the wave movement was less than 5%. This is comparable to W which, with the degree of vacuum being 1(unclear)$\times 10^{-9}$ atmospheres and the beam current being 5 microamperes, shows a stability giving wave movements of less than 2% every 10 minutes. This is true while Ta's requirement for vacuum is at least 1 to 1.5 orders of magnitude smaller.

It is possible to see from the Ta field emission characteristics above that it can be expected that it will function as one type of relatively ideal field emission material, possessing relatively broad applications and prospects for development.

Research on Single Point Emission Cathodes

Xie Xinneng

Scientific Instruments Plant of the Academy of Sciences of China

In 1969, A.C. Crewe[1] first brought up the appropriateness of using field emission cathodes for electron microscopes. These have been used right along up to the present time. Moreover, from now on, the various types of high capability electron microscope electron sources cannot but belong to this type. The advantages of these sources are high luminosity, small cross over bands, low (unclear), and long life. However, they also have several disadvantages. Besides requiring super high vacuums, beam currents are not stable ($\Delta I/I \approx 4\%$). There is normally a requirement for "Flash". Their structures are complicated, drawing out electrical potentials of between 2 thousand volts and 6 thousand volts. Because of this, it is not (unclear) W,LaB6 cathode usage to be universal.

Field emission electron guns are electron microscopy's third generation electron sources. They are composed of field emission cathodes, lead out electrodes and anodes. The cathodes are small sections (unclear) (on average 3 millimeters long) of ϕ 0.12 millimeter single crystal tungsten. At the tip of an ordinary tungsten wire (unclear), after use is made of electrolytic corrosion, the point terminal is an approximately R=1000 Angstrom (unclear) emission body. It is approximately 2 millimeters distant from the draw out electrode. The point terminal field strength E can be calculated from the equation below, that is,

$$E = V/aR \qquad (1)$$

In this, a is a correction (unclear) coefficient. Obviously, the draw out electrical potential or voltage V must, at least, be larger than 1 thousand volts. Only then is it possible for the point terminal surface E to reach the order of magnitude of 1×10^{10} volts/millimeter.

Professor Luo Enze presented an even more precise (unclear) formula[2].

$$E=2\tilde{K}V/\exp^{(-2\bar{K}\Delta d)}-1 \qquad (2)$$

In this, $\tilde{K}$ and $\bar{K}$ are, respectively, the average values for the curves of equal work and equal travel (unclear). Experiments clearly show that even though (unclear) the distance between small draw out electrodes and point terminals Δ d has low electrical potential or voltage across it, it is still possible to reach sufficiently high field strengths E. On the basis of this principle, we designed and test manufactured a type of cathode with structures completely different from those discussed above. Δ d can be controlled to within several microns. On the point surfaces of tungsten wires, it has blown unto it (unclear) a set of 1-2 micron thick insulator (unclear). After that, one sprays on (unclear) metal to act as draw out electrode. One has the selectively corroded point section (unclear) metal and insulation layers. The point of the tungsten wire protrudes out. In this way, it is possible to get the smallest possible distance between emission points and draw out electrodes (at the micron order of magnitude). This also guarantees the concentricity of the two, causing them to form one body. The structure is greatly simplified and reduced in size. These advantages cannot be matched in any way by conventional field emission electrodes. Now, draw out aperture diameters can be controlled to approximately ϕ 4 microns (unclear). That is, the distance between point terminals and draw out electrodes is 2 microns. On the basis of this cathode structure and

dimensions, using calculations and the results of calculations (unclear), one obtains: draw out electrical potential or voltage V=150 V, point terminal E=1.095x10^7 V/millimeter. When V=500 V, E=3.65x10^7 V/millimeter. Compared to the currently popular field emission cathode's three working (unclear) voltages, this is ten times lower. It demonstrates that, in all categories, it has longer useful life and greater emission stability. As far as the improvement of electron microscopy functions are concerned, it will doubtless prove extremely advantageous. This type of single point, low voltage field emission cathode's emission properties, in electromicroscopy applications, will show results later on.

REFERENCES

(1) *A·C·Crewe, et al., Rev. sci. Jnstrum., 39, 576, (1968)*

(2) *Luo Enze, J. Rhys. D: appl. Rhys. 19, 1, (1986)*

Applications of Liquid State Metal Ion Sources in Surface Analyzer Devices

Wang Yiman Wu Yongde Huang Lin

(Ministry of Machinery and Electrical Equipment, Research Institute 12)

Ever since liquid state metallic ion sources entered the practical application stage, they have undergone close to ten years of development. Already, in two large realms, they have held steadily and firmly to their position in applications. One of these is in the realm of integrated circuit manufacturing to do such microcircuitry processing as micro area corrosive etching and infusive pouring. The second is in the realm of surface analysis, acting as excitation sources in surface analyzer devices using ions as probe beams. They are used in scanning ion microscopes, and, secondarily, in ion mass spectrogram devices as well as flight time spectrum devices and other similar micro area analysis instruments.

The gallium liquid state metallic ion source that was test manufactured by the laboratory in question adopted for use a coaxial needle type structure. A material storage device is made from tantalum or porous tungsten tubing. A tungsten needle is the carrier body for liquid state gallium. The continuous operating life of the source is capable of reaching 600 hours or more. In focused ion beam systems, the angular current strengths of ion sources and the beam current density hitting the target as well as energy scattering are directly related. Due to the fact that angular current strength and energy scattering or diffusion are both such that they increase when

the overall current goes up, the ion source operating current has an optimum value. There is already research which clearly shows that, when operating currents are approximately 2 μA, liquid state metallic ion sources are in the most optimal operating configuration when used in focused ion optical systems. The smallest current which can be obtained and can be stablized is almost completely decided by the manufacturing technology of the source. The infiltration or soaking status of liquid state gallium on the tip of W needles is excellent. Stable currents which have already been obtained are capable of reaching 1-2 μA. With beam current stability levels of 2-5 μA, the empirically measured results are $\pm$1.5%/hour. Experiments clearly show that beam current stability levels are also related to source operating temperature, beam current size and the degree of the environmental vacuum. The stable operating temperatures of gallium sources and draw out temperatures (this refers to the temperatures of sources when they begin to draw out current after a long period of shut down in operations) drop as the degree of vacuum rises. When the degree of vacuum is higher than 10^{-7} atmospheres, gallium sources are capable, in situations where temperatures are slightly warmer than room temperature, of drawing out current, and, in conjunction with this, operating stably at room temperature. However, when the degree of vacuum is lower than 10^{-6} atmospheres, the temperature required to maintain stable operations is raised to 200-300°C. The draw out temperatures then required are even higher.

The gallium sources described above, with an ion gun composed of a level or order lower spherical aberration lens, with an acceleration voltage of 5kv, when stops are not applied, are capable of obtaining beam currents on target of approximately 5×10^{-7}A and beam bands of <1mm. This is relatively similar to the characteristics of the VG Company's AG61 Focus A (unclear) ion gun. However, the structure is even more compact. Taking this gun and using it with the Ursus (unclear) electron energy spectrum device, in situations where there is no need for a gas load, it has been successfully used in sample surface cleaning and corrosive etching. This spectrum energy device was autonomously manufactured by the laboratory in question. After

using 0.2 μA beam current in corrosive etching against contaminated areas 4mmx4mm on an Ag surface, surface impurities such as C,O, and N, as well as other similar materials were, then, completely eliminated, obtaining a pure Ag Ursus spectrum. If one makes use of this gun against a silver membrane on a 20nm Cu base to carry out corrosive etching, and, in conjunction with this, carries out a comparison with the AG61 ion gun, under the same conditions, the speed of the corrosive etching with the former is approximately twice that of the latter. Moreover, it does not show the clear contamination of Ga. This gun has already operated for a year in analyzer devices. After the addition of stops, the ion gun discussed above is capable of obtaining micron beam bands and nA level currents. It is just now being used experimentally in the VG Company MICROLAB MKII instruments, and, in conjunction with this, it is being compared to the AG61 model Ar ion gun.

Experimental Research on the Stability of Emission Beams In High Vacuum Fields

Meng Xianji

(Xian Communications University, Electronics Engineering Dept.)

As far as whether or not one has field emission beam current stability is concerned, this is the deciding factor in whether it is possible or not to make applications of them in electronic displays and analysis instruments. It is generally recognized that instability in field emissions is due to emission point terminal surfaces absorbing gas molecules and ion bombardment they are subjected to. The method decided upon up until now has been the application of super high vacuums. Normally, beam current stabilities are capable of reaching 10%. With the assistance of the addition of heat to anodes in order to eliminate gases and other similar methods, beam current stabilities are capable of reaching 2-5%. However, what this article describes is, in the presence of high vacuum (not super high vacuum), and in situations in which differing conditions such as cathode curvature radii, draw out voltages, cathode temperature, the status of cathode surface cleanliness, and single electrode shoe lens magnetic fields combine, and experiments are carried out, that one obtains beam current stabilities ≤10% and results showing cathode lives of > 30 hours. In conjunction with this, using these results in high speed scan electron microscopes to make image formation experiments, one obtains clear and precise images. This clearly shows that, in high vacuum, searching for conditions to realize field emission stability is possible. In high vacuum, realizing field emission beam current stability, for the broad application of field emission electron guns in electron microscopy and analyzer devices, and, therefore, to electron microscopy and the increasing of analyzer device capabilities and the lowering of production costs, has extremely important significance in all cases.

Calculation of the Optimum Mix Cross Sections for Effective Vacuum Emissions from Weak Silicon n'p Concentration Av..anche Electrons

Xu Jingfang Tang Shihao (unclear) Yuan (unclear) Meiying

(Huadong Teachers College, Electronic Science and Technology Dept.)

Lin Chenglu

(Academia Sinica, Shanghai Metallurgical Research Institute)

Zhang Duan Jin Beier

(Shanghai Electrical Vacuum Research Institute)

Using an extremely low energy (≤25kev) infusion of arsenic ions as well as quick heating and annealing techniques on (100) silicon substrate, we formed an extremely weak n'p combination or amalgam. The joining surface of the n'p combination was parallel to the surface of the silicon slice. In appropriate position offset reactions, we induced n'p combination avalanche puncture. A portion of the avalanche electrons will be emitted toward the outside of the body in a direction perpendicular to the surface of the silicon slice. The electrons radiated outside the body are collected on plate electrodes. Taking the silicon slice and sealing it into a vacuum tube at $10^{-(\mathrm{unclear})}$-$10^{-40?}$ atmospheres, we, then, created a silicon avalanche radiation vacuum diode. In this avalanche emission vacuum diode, the efficiency of electron emission, that is, the ratio between the number of electrons radiated from the surface of the silicon into the vacuum and the total number of avalanche electrons, is related to the cross section or profile of the boron-arsenic mix. It is related to the status of the surface of the materials and the conditions of the vacuum.

This article makes a report on the preparation of samples, infusion technique conditions, as well as the distribution profile of experimental measurements under differing mixture condtions. It discusses the relationships between these factors and emission efficiency. The important points in the report are to form theoretical calculations for the optimum mixture profile distributions in $N^{+}P$ combinations effectively radiating into the vacuum and, in conjunction with this, make a comparison with the results from experimentation.

The Test Manufacture of Vacuum Microelectronic Diodes and Vacuum Microelectronic Triodes

Luo Enze

(Xian Electronics Science and Technology College)

Wei Chun (unclear)

((unclear)shan Microelectronics Research Institute)

This article introduces the principles of the effects in our utilization of point terminals and microelectronic techniques which are the theoretical foundation for the test manufacture of microelectronic vacuum diodes and microelectronic vacuum triodes that involve dimensions of only microns. It deals with technical processes, capability standards, existing problems, as well as the prospects for the application of these tubes.

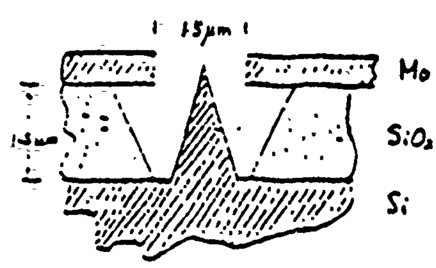


Fig.1 (unclear) Emitting Body

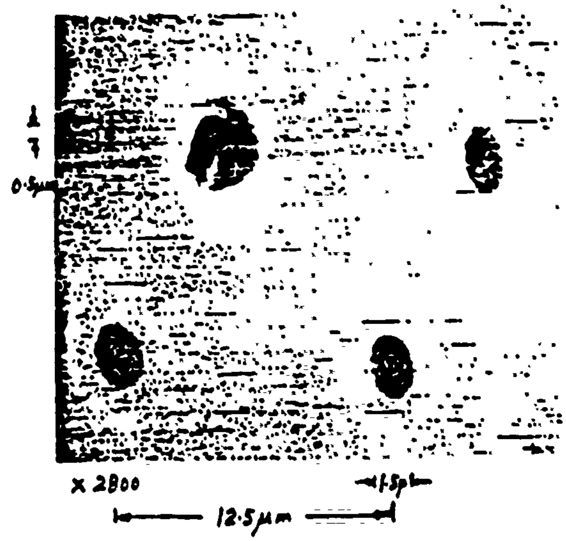


Fig.2 Electron Microscope Image

A Circuit Analysis of the Structure of Thin Membrane Field Electroemission Electron Sources

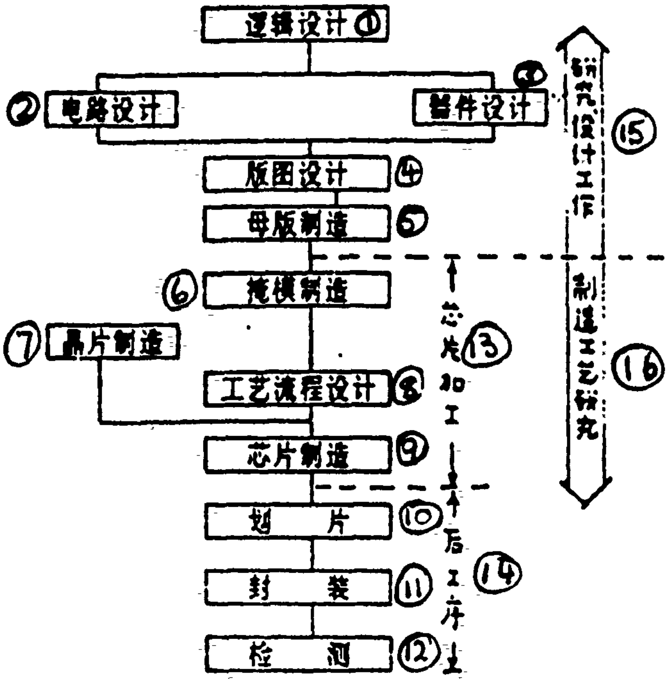
Liu Guangyi
(Academia Sinica, Electronics Research Institute)

Song Luning
(Beijing Lianda Electronics Engineering Institute)

In the middle 1980s, the thin membrane or film field effect emission electron source developed by the U.S. Stanford Research Institute (TFFEC) took another step forward in its development. Due to the fact that it opted to use reaction ion beam corrosion (RIBE), multiple beam electron beam luminescence (MBEL) and other similar ones of the newest techniques associated with large scale integrated circuits, it is already possible to attain sealing and loading densities of $10^{7\text{(unclear)}}$ points/sq.cm (5 fold higher than before). Corresponding with such high sealing and loading densities as these are aperture form dimensions with uniformities which are still capable of being maintained at ±1.5%. Moreover, these are not at all extreme limits. It has been clearly explained that TFFEC fills the role of a type of electron source associated with special structures, having extremely great potential power, and a promising future. This type of electron source is not only capable of operating in instruments with conventional dimensions. In vacuum instruments, it gives out (10-400) A/cm^2 of unheated current density. Moreover, its excellent characteristics within extremely close distance limits (such as microns) are also capable of demonstrating a considerable capability for broad applications. In recent years, internationally, in order to promote development in this area, we have called together the Vacuum-Microelectronic International Conference.

In situations in which the degree of integration and emission currents already satisfy basic requirements, one sees processing and analysis already achieving data requirements, that is, on the basis of TFFEC manufacturing and practical application targets, straightening out the technical flow chart for TFFEC, analyzing the distribution parameters for TFFEC structures, and providing accurate and reasonable structural restraint conditions form the basis for TFFEC design. In this article, the diagram takes a first step in this direction. First of all, it analyzes and establishes TFFEC on a silicon slice or substrate technical foundation. It takes it and views it as a power MOS instrument. Borrowing for use the analysis of large scale integrated circuits, one takes its test manufacture period and divides it up into the procedure shown in the figure below. Again, prime attention should be paid to the analysis of related problems above the dotted line in Fig.2, laying stress on logic analysis and circuit analysis.

The realms or domains that are involved in logic design are emission physics as well as the selection of technical paths for realization, superficially working out a course for actualization. Following that, on the basis of current density, operat'ng pulse systems, power, initiation speed, electron speed distribution and static as well as other similar requirements, one calculates the circuit distribution parameters, carries a step further calculations of the transient processes of cathode structures and of operating characteristics, supplying reference data for the design sketches, having relatively great reference value for applications.



(1) Logic Design (2) Circuit Design (3) Instrument Design (4) Board Layout Design (5) Mother Board Manufacture (6) Masking Pattern Manufacture (7) Crystal Chip Manufacture (8) Technical Flow Chart Design (9) Core Chip Manufacture (10) Chip cutting (11) Sealing and Mounting (12) Checks and Tests (13) Processing of Core Chips (14) Order of Later Work (15) Research Design Work (16) Manufacturing Techniques Research

Using Advanced Electronics Beam Exposure to Prepare Field Emission Cathode Display Optical Masks or Covers

Luo (unclear)jiao Wang Guoguan Wang Qinmei

(Chinese Academy of Sciences Shanghai Metallurgical Research Inst.)

When using traditional optical methods of manufacturing plates (unclear) in the preparation of optical covers or membranes for electroemission radiation cathode arrays, because of the diffraction effects that exist in the light, this presents an obstacle to the precision and miniaturization of plate manufacture. As far as the diagram forms which range from line widths in the low microns even down to the submicron level are concerned, we opted for the use of advanced beam or bundle exposure optical methods which then provide clearly superior characteristics.

The authors opted for the use of our country's most advanced electron beam exposure x-ray devices at the Shanghai Metallurgical Research Institute, and did research on the possibility of manufacturing electroemission or field effect radiation optical covers or masks for cathode arrays.

When electron beam exposure optics enters into the realm of low micron and submicron processing, it meets with the problem that electrons radiate into the processing layer and base causing scattering and back scattering as a result of which, in the manufacture of components that have not been optically exposed, they also reach optical exposure threshold values, that is, what is known as the "proximity effect". This severly limited increases in the precision of processing at the submicron level. The authors, on the basis of the special characteristics of raster or grate scanning (unclear) type electron beam exposure optics, made use of electron antierrosion or corrosion agent thin rubber or gum technology and

methods of multiple optical exposures to assist the optical exposure and have already successfully produced 0.5 micron line width GaAs integrated circuit optical covers or masks. Along with this, they have produced the highest level domestic GaAs integrated instrument devices. The authors discovered that this type of method is appropriate in the same way for use in the preparation of cathode round aperture array boards or plates.

In order to form a 1 micron diameter round aperture array or arrangement, the authors, for the first time, brought forward a new type of method. They used round electron beam beam exposure optics on 4 adjacent processing points. They made use of the "proximity effect" to accumulate the results of electric charges on the round portions inside the four processing points. They formed approximately 1 micron diameter or submicron level diameter round aperture array optical covers or masks.

This article presents a current experimental intermediary product. This clearly demonstrates that it already possesses a definite practical nature.

A Way of Raising the Spindt Cold Cathode Emitting Capabilities

Liu Weidong Luo Enze

(Xian Electronic Science and Technology College Physics Dept.)

Using methods for the calculation of boundary elements to calculate the field strength distributions for cathode structures as given in Reference (1), one combines their working voltages, radiated currents, and, with experimental data, one carries out analysis. One discovers that the structure with the relatively stronger radiated energy (that is, the structure in which the tip of the cone protrudes out into the gate electrode and the gate electrode aperture diameter is relatively small) has an operating terminal field strength that is, on the contrary, relatively small. This clearly demonstrates that the field strength certainly is not determined by the single important factor of electrode radiated energy. This article carried out analyses of this phenomenon from such aspects as field volatilization, terminal equipotential surface shapes, space charge effects, absorbing and lowering escaping power, and other similar aspects, explaining and pulling together, in a comprehensive way, ways of raising the cold Spindt electrode radiated energy, and trying to sketch out a line of thinking on the optimization of designs for vacuum microelectronic device structures.

Reference Material: (1) C.A.Spindt, et al J.Appt.phys.,47(12),1976.

Calculation Methods for Boundary Elements of Spindt Instrument Electric Fields

Liu Yun(unclear) and Zheng Maosheng

(Xian Electronic Science and Technology College)

The core components of Spindt instruments are pointed cone cathodes and band aperture flat plate grid electrodes. Their electric fields possess axial symmetry and periodicity. This article opts for the use of boundary element methods and did numerical value analyses on this electric field. Among these, what is principally discussed is the set up of boundary conditions, the establishment of basic solutions, the dividing up of boundary elements, the calculation of matrix elements, and the precision of the results of the calculations.

The important results were as follows:

The boundary integral equation is

$$c_i u_i = \int_S (u q_i^* - q u_i^*) ds$$

In this, u is the electrical potential. $q = \partial u / \partial n$. n is the exterior normal line. s is the boundary line of the axially symetrical field in the plane r-z.

The basic solution is

$$u_i^* = -r \int_0^{2\pi} \frac{-1}{R} d\phi, \quad q_i^* = r \int_0^{2\pi} \frac{R}{R'} d\phi$$

In this

$$R^2 = r^2 + r_i^2 - 2rr_i\cos\phi + (z - z_i)^2$$
$$R_n = (r - r_i\cos\phi)\frac{dz}{ds} - (z - z_i)\frac{dr}{ds}$$

(r, z) is the coordinates of the linear element ds. (r_i, z_i) is the coordinate of a given point i.

The boundary element equations are

$$c_i u_i = \sum_j (H_{ij} u_j - G_{ij} \cdot q_j)$$
$$H_{ij} = \int_{s_j} q^* ds, \quad G_{ij} = \int_{s_j} u^* ds$$

In this, s_j is the jth boundary element. If we take it to act as a straight line, then, it is possible to use analytical methods to calculate out the integral on top of it. Again, making use of Gaussian methods for deriving integrals, one calcualtes the integral of ϕ.

On the basis of the methods brought out in this article, it is possible to directly calculate the electric field strengths of the vicinities of point terminals. On the other hand, it is possible to make use of the Spielrein formula to calculate the radii of curvature of point terminals, and the actual numerical values differ from each other 1%. Because of this, the calculation results are reliable.

Simulation Calculations for Electroemission Currents Between Detection Probes and Samples

Tang Tiantong Song Jianping Wang Qingsheng

(Xian Communications College Electronic Science Technology and Instrumentation Research Institute)

On the foundation of the constructing of a scanning tracking microscope (STM), use was made of the principles of STM near field effects, and we also took further steps in the design and manufacture of microprocessing or machining devices in order to make it easier, on silica chips, to process or work lines and diagram shapes at the submicron level. This includes the design and manufacture of super high vacuum chambers, the test manufacture of three dimensional scanning devices with a large scanning range, research on super thin antierossion agents, and other similar items.

We also carried out computer simulation calculations on field emission systems between probe tips and samples. When scanning tracking microscopes are in operation, the distance between probe tips and samples is approximately 1nm. Moreover, during close or proximate field microprocessing, the distances between probe tips and samples are approximately several tens of nm or more. Making use of simulated electric charge methods, one solves for the electric fields of radiation systems. Using semi-infinite length line charges with line densitites of τ and point charges with amounts of charge Q positioned at $Z_{o(unclear)}$ as well as mirror image charges in order to simulate the electric fields on planes between probe tips and samples, one can see the diagram as shc ꞉ in Fig.1. Making use of this physical model, we change the values of τ, z_o, and Q, and it is possible to simulate the field emission systems when there are different configurations (including probe terminal radii R and conic

angle θ) as well as different operating conditions (including tracking voltages U as well as probe tip-sample distances S). One makes use of the simulations to conduct analyses and it is very convenient to calculate the current density distributions of field emission systems. Along with this, one obtains the effects of changes in various types of parameters on microprocessing resolution. This sketches out the parameter numbers for periods of optimal operational configuration. This lays the theoretical groundwork for STM proximate field effect microprocessing.

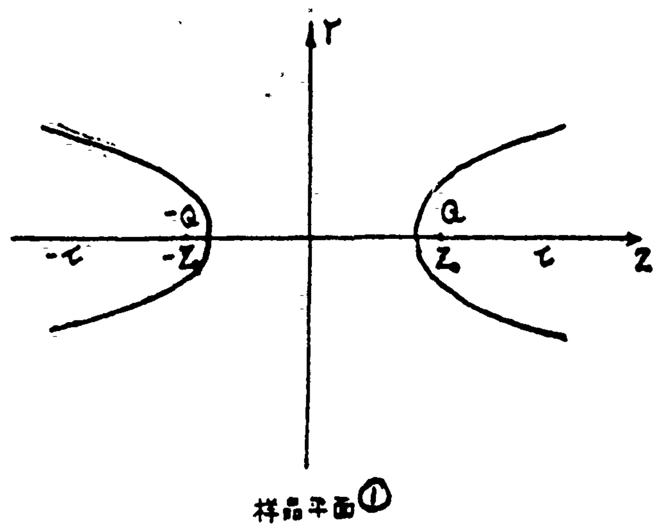


Fig.1 Physical Model of Field Emission Systems (1) Sample Plane

Monte Carlo Method Simulation of Gas State Field Ion Sources

Qiu Bocang Tang Tiantong

Xian Communications College Electronic Science
Technology and Instrumentation Research Institute

Focused ion beam technology ion beam exposure in the submicron realm, microprocessing, ion infusion, and other similar aspects have the prospect of broad applications. These applications strongly depend on ion source characteristics such as angular brightness, ion energy dissipation, virtual source dimensions, and so on. In this article, we used Monte Carlo methods to simulate gaseous state ion source ionized space charge effects, that is, Boersch effects. In this article, research was done on the initial conditions for the production of ions, that is, ion energy distribution, time sequence distribution, as well as location distribution. This supplied us with a random sampling method using computers to discover the distributions described above. In this article, use was made of the fourth order Longge-Kuta (phonetic approximation) methods to calculate electron tracks. When calculating these tracks, consideration was given to dissipation storage effects between ions as well as mirror image effects in the vicinity of metal field radiating probe tips. In order to raise the precision of the simulation, consideration was given to edge effects. In order to save calculation time, we opted for the use of variable step length techniques. In this article, the simulation programs were written in the FORTRAN language. Calculations were made of large numbers of practical examples. Finally, we got ion energy distributions for different reference surfaces, half widths for energy distributions, dimensions for virtual sources, and their locations.

The Relationships Between Surface Curvatures and the Surface Electrical Charge Density Distributions for Several Types of Independent Band Electrical Conductors

Cao Guoliang

(Zhejiang Ningbo Middle School)

This article goes through calculations for several types of configurations in terms of different surface charge densities σ on isolated charged conductors and surface curvatures k. It was discovered that there was a common relationship between σ and k on the several configurations of charged conductors:

$$\sigma^2 \propto k$$

The surface curvature function f(x,y,c)=c for several types of conductors as discussed in this article possesses the property such that if $\frac{\nabla^2 f}{(\nabla f)^2}$ is a function

f, then, the Laplace solution can be written in the form

$$\Phi = A_1 \int \exp\left[-\int \frac{\nabla^2 f}{(\nabla f)^2} df\right] + B_1$$

The Laplace solutions for the several types of configurations of charged conductors discussed can all be found in the "Notes" of the article. These solutions are all capable of being written in the form Φ (f(x,y(unclear))). Solutions in this type of form clearly satisfy all the requirements of boundary conditions, because, when moving points fall on the surface of conductors, f(x,(unclear),z)=c,

therefore, $\Phi(f(x,y,z)) = \Phi(c)$=constant. Satisfying the charged conductor surface is a requirement of equipotential surfaces.

$$\begin{aligned}\because \sigma = \varepsilon E &= \varepsilon|\nabla\Phi| \\ &= \varepsilon\left|\frac{d\Phi}{df}\right|\sqrt{\left(\frac{\partial f}{\partial x}\right)^2+\left(\frac{\partial f}{\partial y}\right)^2+\left(\frac{\partial f}{\partial z}\right)^2} \\ &= c\sqrt{\left(\frac{\partial f}{\partial x}\right)^2+\left(\frac{\partial f}{\partial y}\right)^2+\left(\frac{\partial f}{\partial z}\right)^2}\end{aligned} \qquad (1)$$

In this, c is a constant or invariable quantity. It can be directly determined from boundary conditions.

This article carried out calculations on several types of charged conductors whose surfaces were second degree or quadratic curved surfaces.

[Case I] Charged spheroids. Their curved surface equation is

$$\frac{x^2}{a^2}+\frac{y^2+z^2}{b^2}=1$$

[Case II] Charged parabolic surfaces formed by rotations around the x axis. Their curved surface equation is $y^2+z^2=k^2+2kx$

[Case III] Charged hyperbolic rotational surfaces formed around the X axis (taking x>0 for -0+). Their curved surface equation is

$$\frac{x^2}{a^2}-\frac{y^2+z^2}{b^2}=1$$

As far as these charged conductors' curved surfaces are concerned, due to the question of their symmetry, their surface curvatures can all be written as

$$k=-(d^2y/dx^2)/[1+(dy/dx)^2]^{3/2}. \tag{2}$$

Making use of the two equations (1) and (2), respectively, to calculate the σ and k for the three types of charged conductors described above, one finds that they have a common relationship:

$$\sigma^2 \propto k$$

Besides this, calculations of charged elliptical column surfaces with genatrix parallel to the z axis, parabolic column surfaces, and hyperbolic column surfaces, going through the same type of procedures, also arrives at the same relationship.

(Note): Cao Guoliang, <u>Physics Periodical</u>, Vol.11, No.1, 1982, p.59

Proofs of G. Green Differential Equations

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This article, on the basis of Gauss's Theorem, $\oint\!\!\oint_s \vec{E_n} \cdot \vec{ds} = q/\varepsilon$ and assistance from the equidistant transform properties of curved surfaces in differential geometry, proves, as far as the "convex conductor surfaces" which are often seen (on the curved surface, there are only points of an elliptical nature) are concerned, that, when there is electrostatic equilibrium on the surface of isolated conductors, the relationship between field strength and the average curvature at a given point on the curved surface satisfies the universal Green differential equation (dE/dn)+2KE=0.

At the same time, it proves that, when n->0, K and n are not related. This will be a useful supplement to the solution of the distribution function (1) of electric charge surface density and field strength.

In the early years (2), although there were elementary relationships from differential geometry that were used to prove Green equations, there were in these, however, mistakes and improper places.

Let us look at the expressed equation $\oint\!\!\oint_s E_n ds = q/\varepsilon$. Along the normal direction n to any given point M on a Gaussian surface (any given equipotential surface) one derives S(This is with first order Gaussian regions E,F,G distinguished. Outside these, the field strength is used as E):

$$\frac{d}{dn}\oint\!\!\oint_s \vec{E_n} \cdot \vec{ds} = \frac{d}{dn}\oint\!\!\oint_s E_n \cdot ds = 0 \cdots\cdots \qquad (1)$$

Along the normal direction to the point M, one cuts out and takes a small line segment $\overline{MM}_2=n$. Because of this, going through M_2, there will be a new equipotential surface S_1 in the vicinity of S. On the basis of (3)

$$ds=\sqrt{EG-F^2}(1-2kn) \tag{2}$$

$$\frac{d}{dn}\oiint_S E_1\frac{\sqrt{E_1G_1}}{1-2kn}dudv=0 \tag{3}$$

Moreover, K=1/2(k1+k2). One sees that k and n are not related. Because this is the case, (3) changes to become

$$\oiint_{S_1}\{\frac{dE_1}{dn}\cdot\frac{\sqrt{E_1G_1}}{1-2kn}+\frac{2kE_1\sqrt{E_1G_1}}{(1-2kn)^2}\}dudv=0 \tag{4}$$

Due to the arbitrary nature of the point M, it follows that:

$$\frac{dE_1}{dn}(\frac{\sqrt{E_1G_1}}{1-2kn})+\frac{2kE_1\sqrt{E_1G_1}}{(1-2kn)^2}]=0 \tag{5}$$

Simplifying this and, in conjunction, taking out the subscript in $E_{(unclear)}$, along with giving consideration to the condition n->0, one then obtains the Green equation (dE/dn)+2KE=0. Due to the fact that, when n->0, dK/dn ->0, it follows from this that it is possible to obtain (1)

$$E=E_0e^{-2kn},\ \sigma_0=\frac{2\varepsilon_0k\Delta V}{e^{-2k\Delta V}-1},\ E_0=-\frac{2k\Delta V}{e^{-2k\Delta V}-1}$$

References

(1) Luo Enze; "Distribution Functions Based on Rates of Curvature for Electrical Charge Surface Densities on Charged Conductors"; Physics Bulletin, 3, 1984.

(2) Wang Guoquan; "Distributions of Isolated Conductor Surface Charge Densities"; Physics Bulletin, 3,1966.

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Generally Applicable Formulae for Problems Relating to Electrical Charge Surface Distributions Based on Surface Curvature Distribution Functions and Solving for Boundary Values

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Point terminal effects and boundary value problems are extremely important in the theory of electricity. Not only is this the case, but they are also extremely difficult problems, possessing important significance for the structural design of all electrical engineering and electronic instrumentation. For a long period of time, with the exception of special situations, it has not been possible, right throughout that period, to find a general form which expresses these problems accurately.

This article goes through the process of taking Laplace equations and changing them to be written as Green equations. In conjunction with this, these equations are solved, and, for the first time, one obtains a general formula for accurately solving the problem of boundary values:

$$E_0 = 2\tilde{k}\Delta v / \{\exp(-2\bar{k}\Delta n) - 1\}$$

At the same time, for the first time, one obtains distribution functions on the basis of rates of surface curvature for electric charge surface densities on conductors:

$$\sigma = 2\epsilon k\Delta v / \{\exp(-2k\Delta n) - 1\}, \quad (\Delta n < 1/k)$$

They not only (unclear) include all the results that were arrived at under different special conditions, but, they are also capable of matching up with good coincidence with all the results of analyses that were already know, the results of experimentation, and the results for numerical values. Because this is the case, we have solved the "point terminal effect" and "boundary value problem" that had continued unsolvable for a long period of time. This possesses important significance for the theory of electricity, the physics of surfaces, electroemmisive or field effect radiation theory, vacuum microelectronics, as well as the delicate structural design for electronics engineering and electronics instrumentation, and other similar fields.

Research on Malter Effect Emission Mechanisms

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As far as the radiation mechanism of Malter effects are concerned, for many years, large numbers of people have said diverse and confused things. Different people, on the basis of various of their own experimental researchs, have concluded that there are different radiation mechanisms. However, there is no one type of radiation mechanism which is capable of adequately explaining, in a completely satisfactory manner, all the experimental results. This article, first of all, makes a generalized introduction of two important radiation mechanisms associated with the Malter effects. After that is done, on the basis of research associated with the experimental results of pervious people, it brings up a new type of theoretical conjecture--the theory of microapertures. In conjunction with this, quantitative calculations were carried out, and the results of the calculations support this theoretical conjecture.

This article recognizes that Malter effects are caused by electroemissive or field effect radiations. As far as the microapertures that exist on the dielectric surfaces associated with radiating bodies are concerned, these microapertures cause the distribution of the internal electric fields of the dielectric to be uneven, and this will produce strong fields in the vicinity of the microaperture positions. When use is once made of electron bombardment of the surface of the dielectric, first of all, one sees the production of normal secondary electron radiation with $\delta > 1$. Because of the highly resistive nature of the dielectric, this type of radiation will cause the dielectric surface to carry a positive charge. These positive charges, in the same way, produce, within the dielectric, an uneven field distribution. The electric field produced by the electric charge on the surface causes one to obtain an even

stronger electric field. As a result of this, it causes the free electrons from the metal base to escape into the dielectric through the tunnel effect. These are accelerated by the electric field inside the dielectric and are radiated out into the vacuum from the surface microapertures. At this time, the initial or primary effects of the electrons do not, in and of themselves, directly kick out the secondary electrons. However, it is necessary to maintain the positive charge of the surface, and, in conjunction with this, this causes (unclear) it to maintain a stable value.

This article makes use of boundary element methods to solve for the electric field distributions of dielectrics. The results of the calculations clearly show that, when the electrical voltage between the electrodes is 200v, as far as different situations are concerned, the field strengths at the locations of microapertures inside dielectrics can reach 10^3-10^4(unclear) cm. This result strongly supports the microaperture radiation theoretical conjecture.

Making use of the theory of microaperture radiation possible to relatively completely explain the experimental phenomena of Malter effects.

Research on High Tc Superconductor Percolation Processes

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This article researched the bond percolation processes of high T_c(unclear) superconducting oxides. From a normal state, it combined electrical resistance R, coordination number Z, and other similar quantities, and arrived at the zero resistance temperature $T_{c(unclear)}$, the critical current density J, and other similar parameters.

First of all, it researched the curve for changes in the rate of electrical resistance as it follows along with the measured temperature. A comparison was made between various types of alterations in temperature as they follow the curve for changes in electrical resistance in a normal state. It was discovered that, following reductions in the coordination number, the zero electrical resistance temperature got lower and lower, with alterations or transformations in width getting wider and wider. In the same way, when the rate of electrical resistance in a normal state increased, the zero electrical resistance temperature got lower and lower, and the width of the alterations or transformations got wider and wider.

Next, we also, on the basis of σ (p) (random conduction), at $p_{o(unclear)}$ and above, because of the great slowness of increase as well as the experimental fact that the critical current density of actual super conducting high $T_{c(unclear)}$ oxides was excessively small, assumed that increases in the critical current density $J_{c(unclear)}$ and increases in the random conduction σ (p) in percolation theory were basically of a similar type. In this way, we obtained a workable method for calculating currents.

Finally, we obtained different J(T) transformation curves following normal state electrical resistance rates from $T_{o(unclear)}$ to the temperature of liquid nitrogen (77k) for critical current densities. We discovered that following increases in the

coordination number as well as reductions in the normal state electrical resistance rate, the critical current densities in the temperature region of liquid nitrogen got smaller and smaller.

The results of calculations clearly show that, as far as methods for further raising $T_{o(unclear)}$ and $J_{(unclear)}$ are concerned, there are: 1) eliminate weak connections, 2) increase effective coordinations numbers, 3) from the basic state, raise the superconducting particles (unclear) so that they enter into the temperature $T_{o(unclear)}$ for times when there is a superconducting state.

Internal Electroemission Mechanisms and Percolation Processes in High Tc Metallic Oxide Superconducting Materials

Luo Enze

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This article brought out the theory of the mechanisms of internal electroemissive or field effect radiations and percolation processes. In order to explain such systems as those with high $T_{o(unclear)}$ metallic oxide superconducting materials like $YB_{(unclear)}C_{(unclear)}O$, it, therefore, brought to light the reasons for changes in critical temperatures.

On the basis of this one mechanism, the high Tc superconducting phenomena which these materials therefore display are due to their forming in their interior regions a limitless number of small metal granules or grains which use the metallic oxides as an insulating layer.

When at the critical temperature Tc and below, on these materials, one applies an initial voltage, and the free electrons of the metal grains inside them will, due to the point terminal effects, gather toward the places on the point terminals where the rates of curvature on the surfaces of the granules are very large. Due to increases in cohesion associated with the formed Copper (phonetic equivalent) pairs, it is possible for them to combine to form into strong Copper pairs with gap energies of $2\Delta > 10^{-14}$ ergs. These strong Copper pairs, due to Josephson (phonetic equivalent) effects, make it possible to tunnel (unclear) through the insulation layer. Because this is the case, one sees the formation of high $T_{o(unclear)}$ superconducting materials with Tc>100k.

We discovered that the size of this critical temperature Tc is primarily determined by the rates of curvature of the metal grain point terminals as well as by the distances between the metal granules or grains. However, the magnitude of the critical currents Jc are primarily determined by the percolation processes inside these

materials.

This mechanism, beyond the causes which are capable of illucidating the fact that high Tc superconducting materials show the appearance of high Tc and low Jc, are also capable of explaining why the superconducting currents in these materials exhibit differences in their various directions, weak isotope reactions, and other similar phenomena.

Percolation Theory and Its Function in the Science of Materials

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Percolation is the theoretical method for handling strong orderless and random geometrical structures and has attained widespread applications in such realms as noncrystalline state physics, (unclear) electroemissive or field effect radiations, as well as materials failure.

Percolation theory entered the limelight through the sharp phase changes that exist in it. On one side of the phase change points, there is a long run of related or interconnected phase. However, (unclear) side, there is no extended range of related or interconnected phase. These two phases possess radically and abruptly different physical properties. The system, in changing from one phase to another, is capable, through the alteration of a certain number of system state parameters (such as temperature, components, pressure, and other similar factors) of displaying the differences that exist on the basis of these state parameters and system structures. It is possible to take the theory of percolation and divide it into the following four types: 1. Bond percolation 2. Position percolation 3. Mixed bond and position percolation 4. Continuous percolation.

This article takes several aspects of percolation theory which have theoretical applications in areas such as material elasticity failures, weakly (unclear) magnetic phase changes, high temperature superconduction, vitrification phase changes, Andersen (phonetic approximation) transformations, as well as dielectric failures, and so on, and analyzes them.

Using Electroemission Methods for Doing Research on Atomic Surface Diffusion in Metallic Single Crystal Surfaces

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Ever since the invention of the electroemissive or field effect radiation microscope by E.W.Muller in 1937, it has already seen 50 years of history up to the present time. Before the 1970's, Muller, R.Gomer, and others, among a fair number of scientists, made use of this simple and convenient tool to directly observe the processes of surface migration in the atoms (or molecules) absorbed on metal surfaces. From these, they obtained a good number of significant and (unclear) bright electroemissive or field effect images. Following along with the vigorous development of surface physics and surface analysis techniques, R.Gomer, in the early 1970's, took the electroemissive or field effect microscope as the foundation, and, from its basic principles to its experimental techniques, invented and created the fluctuation method. As a result of this, he realized, on single crystal surfaces, the (microscopic) precise determination of surface diffusion coefficients and activation energies for atoms (or molecules) absorbed on metallic surfaces. It is very suitable for use in research on surface migrations and under conditions of degrees of overburden or covering which do not vary and are effective for atoms (or molecules) which are absorbed on single crystal metallic surfaces. From these, it is possible to obtain a good deal of information relating to the atoms of metallic surfaces and the mutual interactions or effects of metals and gases.

This article introduces the basic principles of research methods, their experimental equipment, as well as the newly obtained results of research. These research results include, in such systems as H_2/W(110),O_2/W(110),CO/W(110),H_2/Ni(100), and other similar

systems, research on the surface diffusion of gas atoms (or molecules), and, in periods of high temperature, surface autodiffusion processes of tungsten atoms on the suface of tungsten steps.

Research on the diffusion of hydrogen (unclear) absorbed on metal surfaces possesses a strange power of attraction for people. At low temperatures (27-140K), the diffusion coefficient D and the temperature are almost unrelated. Within this temperature range, the diffusion of hydrogen (unclear) atoms on the W(110) surface is called tunnel diffusion. This is a special phenomenon possessed by hydrogen (unclear) atoms (light mass). In the range 75-90K, curves all exist in a minimum value. The temperature region located with this minimum value changes for different degrees of overburden or covering. It corresponds precisely to the occurence of a type of "phase transfer". During periods of relatively high temperature (140-180K), the value of D follows the rules of transformation that say that it increases with increases in temperature and obeys the equation $D=D_0\exp(-E/KT)$

At this time, hydrogen (unclear) atoms show diffusion on W(110) surfaces that is called heat activation diffusion.

Using the electroemissive or field effect fluctuation method, this article also measured surface autodiffusion and thermal coarsening processes for tungsten atoms and atom imperfections in microregions that were probed and measured along W(011)-W(112) and W(011)-W(001). In the first region, "fast" surface diffusion is single tungsten atoms doing two-dimensional diffusion on flat steps. "Slow" diffusion is imperfect tungsten atoms doing one-dimensional diffusion along steps; however, at 950-1000K, this turns into two-dimensional diffusion. At this time, the tungsten step structure of the surfaces gives rise to heat or thermal coarsening. In the second area, heat coarsening occurs at the even lower temperature of appoximately 750K.

Low Temperature Ultraviolet Hg Sensitized Optical Gaseous Phase Accumulated SiO_2 Thin Membrane Research

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Summary:

Photochemical vapor deposition is a type of low temperature thin chemical membrane technology which has a very bright future. SiO_2 thin membranes which are formed by the use of this technology are capable of being used in diffusion masks or covers and VLSI multilayer wiring, as well as in the gaps between active instruments, the dielectric grids of MOS instruments, passivated semiconductor instruments, and so on, and so forth. Under low temperature conditions, one uses ultraviolet Hg sensitized optical-CVD technology to prepare dielectric masks, causing instrument manufacturing to rid itself of the effects of high temperatures. At the same time, due to the fact that the photolytic energy is not adequate to cause the gas molecules to ionize, during the process of ultraviolet Hg sensitized photo-CVD, there are no high energy ions produced. Because of this, as far as instruments are concerned, such ions are not able to do any damage. Because this is the case, it is possible to maintain the characteristics of the various types of instruments while increasing their reliability.

Percolation Mechanisms of Electrical Conduction in Thin Metallic Membranes

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This article conducted research on the relationship between thin metallic membrane electrical conductivity characteristics and membrane thickness. Taking as basis the random statistical laws which form the core of experimental observations and measurements of island shaped thin membranes, it recognizes the fact that electrical conduction in thin metallic membranes is a process of continuous percolation. From a theoretical point of view, it elucidates the mechanism of percolation in electrical conduction in metals. It discovered that, when the thickness of metallic membranes approaches 1nm, one then sees the appearance of percolation phenomena. Moreover, after giving rise to percolation, the electrical resistance follows changes in the thickness of the membrane in a semilinear relationship.

Research and Development Related to Thin Membrane Electroluminescent Screens

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(I)

At the present time, flat plate display instruments which have been recognized as possessing value for practical application and have been given serious attention everywhere, have three types: liquid crystal display instruments (LCD), plasma body display screens or panels (PDP), and thin membrane or film electrically induced or field effect luminsecence screens or panels (TFELP). Outside China there are people who recognize that, in the future, the only flat plate display instrument that will be able to compete with the electron beam display instrument or cathode ray tube (CRT) is the TFELP. This article performs an analysis of the thin film field effect luminescence mechanism and such characteristics of the TFELP as reaction time, image contrast gradient, and other similar items. It recognizes that the point discussed above has a certain persuasiveness.

(II)

We have made a comprehensive discussion and anaylsis of the level that TFELP has already reached at the present time outside of China. In conjunction with this, we have carried out a comparison of LCD and PDP. This included: (1) screen dimensions and resolution (2) color and brightness (3) contrast gradient (4) viewing angle (5) power consumption (6) life.

(III)

At the present time, the main directions in TFELP research are in two areas:

1. Lower the operating voltage of TFELP, which includes

(1) research new luminescent film materials and preparation methods which are capable of operating at relatively low field strengths

(2) improve the mass in TFELP dielectric films in order to reduce their thickness

(3) start exploitation of dielectric film materials with high dielectric coefficients which are suitable for applications in TFELP.

2. Research color and even panchromatic TFELP to include:

(1) begin the exploitation of color phosporesent bodies or phosphors

(2) Color and panchromatic TFELP structural designs. At the present time, this area has already seen the appearance of laminated structures, design or pattern type print structures, and composite type structures (three types of forms).

This article then carried out a general discussion and analysis of the various areas discussed above. In conjunction with this, it pointed out that if one opts for the use of (unclear) projection techniques and makes use of design or pattern type printed structures, there is a possibility of large scale production of low production cost large screen, high resolution TFELP.

(IV)

TFELP acts as a completely solid state flat plate display instrument that has already shown its superior characteristics in such fields as the military, aviation, medical treatment, and experimental equipment. However, TFELP also belongs to the class of high technology products. Because of this, within the forseeable future, it is not possible to expect us to go through an entry into the technological development of TFELP for our country, which is necessary for it to gain a foothold in China. We appeal to the relevent ministries and departments to give the needed attention to this.

Research and Applications Relating to Electroluminescence Matrix Display Screens

Zhang Renlin and Pei Changxing

(Xian Electronic Science and Technology College)

Electroemissive or field effect luminous matrix display screens are a type of new model flat plate dynamic display screen. Due to the fact that its power consumption is low, its luminosity rating is high, the fact that it possesses response times in the microseconds, and the ease with which its actualization can be turned into a flat plate, as well as other similar points are several of its strong features. Moreover, it has drawn widespread attention from people. However, due to the fact that the electroemissive or field effect luminosity materials have low brightnesses, they are difficult to realize in a form with color, as well as such problems as the fact that, on the matrix screen, one sees the existence of crossing or crossover effects, at the present time, they have still not yet obtained broad application.

This article synthesizes our research work over the last few years, it introduces electroemissive or field effect luminosity principles, the preparation of materials, the technology of matrix display screens, the elimination of crossover effects, methods and measures to raise display contrast gradients, as well as microprocessor controlled complete dynamic display of written characters and graphics with design plans for such items as software and hardware.

Color Electroluminescence Display Instruments

Jia Zhenggen

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This article primarily introduces the current level, structure, and development directions of color (panchromatic and multicolor) electro (field effect) thin membrane or film luminescent display instruments. The important point is to introduce two types of classic electroluminescence display instrument structures (One type is the band filter color instrument. One type is the active matrix location selector type.), their levels, important manufacturing techniques, and their current and future development trends. At the same time, it also introduces the structure and capabilities of a type of multicolor thin film electroluminescence display instrument that has special ports. Besides that, it also takes the chance to introduce the general situation relating to luminescence powders and the general development situation of several types of main advanced luminescence powders, as well as the characteristics and luminescence brightnesses of several types of main advanced luminosity powders. The whole article is somewhere over 4000 characters with 4 figures.

The Design of Flat Plate Electroemission Flourescent Display Screens

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Electroemissive or field effect radiation flat plate flourescent display screens are a type of new model display instrumentation which is capable of actualizing the change toward light, thin membranes or films. As far as a comparison of it with cathode ray scanning flourescent tube liquid crystal displays, electroemissive or field effect luminosity, as well as plasma body and other similar types of display instruments is concerned, it has still not given rise to universally serious interest. However, looking at it from the point of view of its basic display principles as well as the situation of its actual test manufacture in the last few years outside of China, various aspects of its capabilities, such as brightness, power consumption, contrast gradient, resolution, reaction time, as well as color and other similar aspects, all possess latent strengths which can compete with any of the other display instruments. At the present time, the most central problem is in the area of its practical technical implementation. The reason for this is that there is a requirement to opt for the use of electroemissive or field effect radiation micropoint array cold cathodes which are manufactured through microelectronic etching techniques at quite high densities of integration.

The important point in this article is to carry out a discussion of the structures and manufacturing operations of electroemissive or field effect flat plate flourescent display screens. Due to the fact that, outside China, as far as this type of display instrument is concerned, there have only been reports of a general nature, there is a shortage of materials on detailed techniques and aspects of characteristics. However, looking at it on the basis of the actual status of thin film field effect cold cathodes that we have manufactured in the past, it would follow, on this basis, that there will be a number of problems with the manufacturing of display

screens. Because this is the case, this article carries out an analysis of the structures of several types of cathode set-ups in an attempt to design a type of cold cathode structure which is capable of simplifying techniques and, in conjunction with that, capable of attaining the required characteristics in the cold cathodes of display devices as well as a technical manufacturing plan.

Luminescence Phenomena of MIM and MI(LB)M Tunnel Structures

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We manufactured MIM tunnel aggregates, and, in conjunction with this, observed luminosity phenomena. In order to raise the rate of luminosity, we also manufactured MI(LB)M structures (metal-insulating layer-LB single molecule film-metal), and observed that there was an increase in the rate of luminosity. All experiments were carried out at room temperature. MIM structures are formed by creating a layer of $Al_{2(unclear)}O_{3(unclear)}$ on a glass base plate by sublimation inlay of a layer of Al and oxidizing it. Again, on the layer of $Al_{2(unclear)}O_{3(unclear)}$, one deposits a layer of metal by sublimation inlay, forming the MIM. Naturally, the thicknesses of the film layers have definite requirements associated with them. After applying a voltage to both sides of the metal film, one is then able to see luminosity phenomena.

After the luminosity phenomena of MIM structures was discovered, there was a great deal of work in experimentation and theory to investigate the mechanism of this luminosity. There have already been definite results. It is recognized that, after one applies an electrical voltage to the two sides of metal films in MIM structures, the Fermi energy levels experience a corresponding positional translation or displacement. The electrons, due to the fact that the tunnel effects bore through the potential barrier formed by the layer of aluminum oxide, during the process of tunneling, take the lost energies of excitation and set off surface electrons and magnetons. From the relative roughness of the surface, they couple into the vacuum, or, due to the actual ups and downs of the tunnel current flow, they will directly couple into the vacuum and be observed.

We made use of a glass plate which had experienced the expulsion of minute amounts of light to make the MIM structure, and we observed no luminosity effects. On a glass plate which expelled light, we first applied a layer of $MgF_{2(unclear)}$, making it form the appropriate degree of roughness. Again, we made up an MIM structure. In conjunction with this, the edge characteristics of the structure were improved, and luminosity was observed. In order to increase the degree of luminosity and brightness, we made an MI(LB)M structure, that is, on the $Al_{2(unclear)}O_{3(unclear)}$ layer, we pulled out a layer of single molecule hard fatty acid film. After this was done, we again completed the sublimation or volatization inlay and observed luminosity approximately twice as great as that from the original MIM structure under the same conditons. We are still carrying out the relevent contents.

What causes people's interest in the phenomena of MIM structure luminosity is the fact that its frequency band is wide, it covers the entire region of visible light, its working voltage is low (1-4 volts), its color is adjustable, it is unusually soft and pliable (in our experiments, this point made a very deep impression), however, its efficiency is relatively low.

This work was carried out with assistance from the National Natural Sciences Fund

Research on a New Type of Noncrystalline Semiconductor Thin Membrane Electroluminescence Device

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As far as electrically induced luminosity devices involving noncrystalline state semiconductor thin membranes or films are concerned, they are a type of luminosity device which has very great prospects for development. Internationally, they have received the attention of experts. This is due to the fact that this type of device has the capability to be made into large surface area display instruments. Moreover, manufacturing costs are low (only approximately one tenth of semiconductor luminosity devices) and they are easy to make.

For many years, we have consistently carried out the work of test manufacturing noncrystalline state semiconductor thin films. We have already produced: Glass/TCO/Pin-a-SiCx:H/Al, Glas/TCO/a-Si:H/Al,Glass/PP-in-a-SiCx:H/Al and Glass/TCO/a-C:H/Al as well as other similar products in the four classes of luminosity device structures. These devices all put out visible electroemissive or field effect luminosity. Their luminosity peaks vary between 4000 A and 7000 A. The strength of the luminosity is such that, using the naked eye, in a relatively dark place, it is possible to see it. The location of these luminosity peaks can also be changed following along with the narrowness of the optical band of the ith region and the technical conditions of manufacture.

This article reports mainly on the electrically induced luminosity characteristics of our recently manufactured a-C:H thin film, the device structure IR, Raman, and ESR spectra, as well as work on aspects of the luminosity mechanism.

Research on Questions Relating to Ceramic Vacuum Capacitors or Electrical Condensers

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High Reliability Product Research Institute)

As far as making use of high vacuums and super vacuums to make dielectrics for ceramic vacuum capacitors is concerned, why, at nominal operating frequencies, is there the occurence of luminosity phenomena (in dark rooms)? In practical terms, at what location does this occur? To what type of light class does this belong? Is it related or not to vacuum breakdown? Is it possible to eliminate or weaken it? These are the types of problems that occupy the attention of producers and users.

Making use of special transparent observation windows, through meticulous observations, it was possible to confirm that luminosity does not exist on the exterior surfaces of the ceramics. It also does not exist between the electrodes. However, it does exist on the interior ceramic surfaces between the terminal portion facing the most exterior electrode plate and the base portion of the metal sealing connector ring.

Through x ray measurements, applying static electric and static magnetic fields, and, in particular, under the effects of the magnetic field, the points of light manifested changes. This proved that this type of light is not electrically induced or field effect luminosity. It is also not luminosity excited by x rays. However, it is from the field effect electric radiation electrically charged particles associated with the most exterior electrode plate's terminal portion bombarding the interior surface of the ceramic shell that produces flouresence.

As far as the capacitors with light are concerned, when they include that electrode plate group of the most exterior electrode plate and there is a connection with the direct current power source's negative electrode, the ceramic shell shows luminosity. When it is

connected to the positive terminal, the light does not appear. This is explained by the fact that charged particles have a negative nature. Also, due to the fact that, inside vacuum capacitors, there are no fixed ion sources, it follows that they must certainly be electrons.

As far as the "voltage at which light is visible" is concerned, (1) in the case of ceramic vacuum capacitors with relatively large leakage currents, after going through certain industrial processes, they showed relatively low "voltages at which one sees light" and "voltages at which one sees fire" (2) with clear increases, leakage currents were clearly reduced, and, after being stored for half a year, when again put through tests, they still did not exhibit any changes. This is explained by the fact that the capacitors that had gone through this type of industrial processing showed that they definitely had increases in reliability. At the same time, it also explains the fact that there is a relationship between luminosity and vacuum breakdown (jump spark). However, there are still areas of difference.

Note: (1) "voltage at which one sees light" is the voltage applied when, in a dark room, one just sees the capacitor produce light. (2) "voltage at which one sees fire" is the voltage applied when one begins to see the occurence of self-sealing punctures or breakdowns.

Modeling and Calculations of Metallic Optical Electroemissions

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For use in the linear accelerators used in free electron lasers (FEL) as well as other similar types of equipment such as high power microwave equipment, it is necessary to be able to produce large current pulse cathodes. Pulse field radiation cathodes have difficulty in stablly obtaining millimicrosecond level narrow pulse widths and low energy diffusion pulse electron flows. Taking laser pulses and "touching off" the operating field radiation cathodes below field radiation threshold value field strengths, that is, realizing a form of light field radiation, it is possible to obtain very high pulse switching speeds. This type of electron radiation form, as compared to the ordinary photoelectric radiation, possesses even higher quantum transformation efficiencies and relatively low photoelectric radiation red limits.

Quoting the basic assumption of the Fule photoelectric radiation model, we set up a model which is suitable for metallic light field radiation research. We derived the fact that, when there is the existence of an exterior electric field, the potential barrier drops down $\Delta\phi$. Constituting the total Np a radiation flow produced by electrons that have been excited, we see included the electron flow of excessive potential barrier j_1 (unclear) and the tunnel penetration electron flow j_λ, respectively satisfying

$$j_1 = Np\,a \frac{4\pi m k T e}{h^3} \int_{-\Delta\phi}^{\infty} d\nu_{zz}$$

$$j_2 = Np\,a \frac{4\pi m k T e}{h^3} \int_{-Wa}^{-\Delta\phi} D(E_x) d\nu_{zz}$$

In this $d\nu_{ex} = \ln[1+\exp(\frac{E_f + h\nu - Ex}{kT})]dEx$. Through analysis and numerical value (computer) calculations, we obtained relationships between light radiation field electrical currents and electroemissive or field effect electric currents under various different conditons. In general summary, the light field radiation special characteristics were as follows:

1. Before light field radiation reachs field radiation threshold values at electric field strengths, it is possible to receive light pulse control, actualizing initiation and shutdown. When the power escaping from the metal is 4.5ev, light field radiation is controlled in an area that can be extended continuously to $3x10^{9(unclear)}$v/m. For $LaB_{6(unclear)}$, it can continue to $1x10^{9(unclear)}$v/m. Using $10Mw/cm^2$ quasimoleculer laser emissions, the radiation electric current density can reach $10^7 A/m^2$ orders of magnitude.

2. Relative to photoelectric radiation, threshold value frequencies drop. In the same way, under light current effects, radiation current densities are capable of rising an order of magnitude. The main contributions come from Schottky effects.

3. At times of minute changes in electrical field strengths, light field radiation is stable as compared to field radiation. The effects exerted by temperature are also far smaller as compared to field radiation.

As far as considering the effects of space charges is concerned, it gives one the voltage characteristics of light field radiaton. Gathering up the relevent experimentation from the French LAL and U.S. BWL laboratories and making an analysis, relevent experiments also are in preparation.

Use of Infrared Lasers (2.06μm) to Produce Four Photon Photoelectric Emissions in CsSb Photoelectric Cathodes

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The Cs3Sb photoelectric cathode photoelectric radiation threshold value is 2.05ev. The photons being radiated inward have energies lower than this, and it is generally recognized that they are not capable of producing photoelectric radiation effects. However, if one makes use of multiphoton photoelectric effects, it is possible to realize an optical spectrum range response which is outside the traditional photoelectric cathode photoelectric radiation threshold values. We made use of 2.06 μ m pulse laser iradiation reflection type Cs3Sb photoelectric cathodes to observe and measure four photon and even higher value photon number photoelectric radiation effects. In conjunction with this, we used experimentation to establish for certain multiphoton photoelectric radiation and non-thermal radiation. We also, on the foundation of the theory of multiphoton absorption in keidysh semiconductors, derived a form to express multiphoton photoelectric radiation. In conjunction with this, we calculated multiphoton photoelectric radiation coefficients in Cs3Sb cathodes. The results of theoretical calculations and experimentally measured values match up relatively well.

The First Test Manufacture of Electroemission Electron Gun Anodes

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In order to test manufacture scanning transmission electron microscopes, we, first of all, began with the test manufacture of electroemissive or field effect radiation electron guns. Making use of electroemissive or field effect radiation electron guns to act as the electron source for high resolution scanning transmission electron microscopes has advantages such as high brightness, little beam striation, and a low degree of energy diffusion. The work of this article is nothing else than the test manufacturing of the first anode electric power source $V_{\prime\,(unclear)}$ with an electroemissive or field effect electron gun useo in scanning transmission electron microscopes. To this end, we did the work set out below.

1. Power source $V_{\prime\,(unclear)}$ controls the size of the electroemissive or fiel effect radiation electron beam current of the field radiation electron gun. This article, on the basis of the requirements for the actual application of scanning transmission electron microscopes, sets out from the theory of field radiation, and makes calculations to derive the various indexes for the power source $V_{\prime(unclear)}$, obtaining its output voltage range to be 500-5000 volts, its output current to be 0-200 microamperes, and a degree of stability which should be better than $9 \times 10^{-4(unclear)}$.

2. Electric power source $V_{1(unclear)}$ is set on a positive high voltage direct current power source on top of the second anode power source $V_{c(unclear)}$(-50KV). In order to be able, in low voltage terminals, to adjust the output voltage of the power source $V_{1(unclear)}$ set on high voltage $V_{o(unclear)}$, and, in conjunction with this, cause it to reach the required level of stability, the authors of this article carried out, on the current reference materials, induction and analysis. Along with this, on the basis of

only the characteristics of differential operation amplifiers amplifying differential signals, they brought up, in sampling circuits, the introduction of differential operation amplifiers. When use is made of $V_{2(unclear)}$ voltage raising or step up transformers to do high voltage isolation, it is possible to realize an adjustment in setting from the low voltage terminal to the power source $V_{1(unclear)}$ at the high voltage $V_{o(unclear)}$. Moreover, the V_1 power source is capable of reaching relatively high levels of stability. It should be pointed out that, in situations where the two power sources V_1 and V_o are connected together, we, in both theory and practical measurements, proved that, when any one output voltage among them is adjusted, there is no influence on the output voltage of the other power source or its level of stability.

3. After we did our calculations on the basis of the theory discussed above, the design also included the power source $V_{1(unclear)}$. Going through installation, measurements and adjustments, we proved that this power source had already reached the stage of practical application. This article gives the complete circuit diagram for power source $V_{1(unclear)}$. In conjunction with this, as far as the operating principles of the various parts of the circuit, the circuit configuration, the effects caused, and the techniques and measures which it is possible to opt for the use of are concerned, they are described.

The results of theoretical analysis and large amounts of experimental measurements and tests clearly demonstrate that the power source $V_{1(unclear)}$ which we designed, when operating with an output voltage of 500-5000 volts and an output current of 0-200 microamperes, has a degree of stability that is better than 1.5×10^{-4}, is better than the design targets, and is capable of satisfying the requirements for use in electron microscopes.

Due to the fact that we opted for the use of differential amplifier methods in its design and manufacture, the stability of power source $V_{1(unclear)}$ is relatively high for that reason, and its operation is very safe. Due to the fact that we opted for the use of methods which we created ourselves to manufacture $V_{1(unclear)}$, it is therefore true that, compared to the same type of power sources made

using traditional methods, the volume of V_1 is small, it is light weight, it is easy to adjust, its stability is reliable, and its cost is low. As far as power source V_0 is concerned, we selected for use products of the Chinese Academy of Sciences (Academia Sinica) instrument plant. Their effectiveness was relatively good.

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Test Manufacture of Electroemission Electron Gun Scintillation and Scintillation Power Sources

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The electron beam current $I_{K(unclear)}$ of cathode radiation in field radiation electron guns as well as their stability characteristics are determined by cathode materials and their crystal orientations, anode voltages, radii of curvature $r_{K(unclear)}$, as well as their proximate electric field strengths $\xi_{(unclear)}$, the cleanliness of the cathode surface, the degree of smoothness, and many other similar types of factors. After precisely specifying other conditions, the magnitude of $I_{K(unclear)}$ is determined by $r_{K(unclear)}$. The smaller $r_{K(unclear)}$ is, the larger $\xi_{(unclear)}$ is, and the larger $I_{K(unclear)}$ is. Besides this, the cleanliness and degree of smoothness of the cathode surface also decisively influence the magnitude and stability of $I_{K(unclear)}$. Cathodes which are not clean or not smooth will cause $I_{K(unclear)}$ to be unstable. Field radiation electron guns with $I_{K(unclear)}$ instability are not capable of being utilized. Because of this, we must establish a method for making I_K stable.

The reasons for field radiation gun cathode surfaces being dirty or not smooth are: (1) the cathode surface will absorb gas molecules (2) going along with usage of the field radiation cathode, its surface becomes pitted because of the bombardment of positive ions. The cathode point terminal will also become bald and blunt. $r_{K(unclear)}$ becomes large. Because of this, making the surface of cathodes clean and making them smooth again, after putting cathodes through processing and scintillation, will make $I_{K(unclear)}$ become normal and stable.

What is called scintillation is nothing else than putting the cathode, during a very short period of time, through a relatively large electric current, making it heat up to a sufficiently high temperature to make the gases absorbed on the surface of the cathode be eliminated. At the same time, the atoms on the surface of the cathode will, because of the high temperature, produce diffusion and "wriggle" or "creep" movements. This will make the surfaces of cathodes which have been bombarded by positive ions and are pitted and uneven, to become smooth again. Because of this, cathodes, after going through scintillation processing, are capable of stably radiating adequate electron current $I_{K(unclear)}$. Field radiation cathodes, after operating for over ten hours or so, then require an iteration of scintillation. Scintillation extends the useful life of cathodes and their effectiveness. In order to carry out scintillation, we took the single crystal tungsten wire used to make field radiation cathodes and welded it to the top end of the protruding fork shaped tungsten wire. During scintillation, relatively large electric currents flow through the protruding fork shaped tungsten wire, and this causes the single crystal tungsten wire to heat up. It should be pointed out that scintillation will cause cathode terminal points to become bald. This is nothing else than what is called "blunting". Because of this, during scintillation, it is still necessary to opt for measures to prevent the blunting of cathodes.

In order to guarantee that field radiation electron guns will be capable of continued normal operation, it is then necessary to carry out scintillation on cathodes frequently. Because of this, we did specialized test manufacture of a scintillation power source installed in the field radiation gun. On this, we performed the following operations. 1. On the basis of the field radiation electron gun cathode material, configuration, structure, dimensions, and method of installation, we calculated out the operating conditions required for scintillation. As a result of this, we precisely specified the functions that must be prepared for power source scintillation. 2. On the basis of power source scintillation functions, we were able to

calculate out the circuit diagram for scintillation power sources. In conjunction with this, on the basis of this design, we manufactured scintillation power sources. 3. On scintillation power sources, we carried out scintillation simulation measurements and tests of cathodes in an atmospheric environment. The results from these measurements and tests should take out such factors as heat dissipation and oxydation. These tests and measurements are carried out in a camera bellows using a photoelectric tube detector. 4. After this is done, we took the field radiation cathode and installed it in the field radiation electron gun to carry out a test utilization and to make measurements and experiments. 5. During scintillation, consideration is also given to opting for the selection of measures for the prevention of blunting.

Due to the fact that our scintillation power sources came into being after going through serious design calculations, and, in conjunction with this, going through step by step measurements and tests, we successfully test manufactured them. Because of this, after making test utilizations, the results were very good. After going through scintillation, the degree of stability $S_{K(unclear)} = \Delta I_{K(unclear)}/I_{K(unclear)}$. Within 10 minutes, it was possible to make it smaller than 1%. The results were very good. In conjunction with this, they have been utilized in field radiation guns.

The Most Newly Manufactured Type of Flight Time Mass Spectra Collection and Processing System

Ye (unclear)sun Huang Guangming Hu Bingyi Liu Wu

(Produced with assistance from the National Education Commission Outstanding Young Teacher Fund)

(Huazhong Normal University)

Traditional atomic probe flight time mass spectra are done on the assumption of the precondition that the greatest number of ions of the same type produced by the volatilization of each high voltage (or laser) pulse is not greater than 1. Because of this, it is only necessary that electron timers record the durations for signals produced by ion detectors. The errors produced by the methods of picking up and collecting numerical data of this kind are very small within the area probed, and, in situations where the voltatilization speeds are very low, they can still be tolerated. However, as far as the "electroemissive or field effect general microscopic display system" which puts primary emphasis on the study of samples with relatively large surface areas, and which we test manufactured, is concerned, they are completely unsatisfactory. As far as image forming atomic probes are concerned, outside of China, it was generally the case that people opted for the use of methods involving oscilloscope displays with photographic records or the use of specialized waveform digitization systems. The former is slow in speed, consumes a great deal of material, and is not very precise. The latter is not only expensive to produce ($100,000 U.S. or more) but suffers from export restrictions. On the basis of the fact that the principal parameters associated with atomic probe flight time mass spectra are the duration and the amplitude of the signals produced, and, in addition, that we were looking for a product that is capable of reaching the required precision, we test produced a set of new model systems which are capable of simultaneously recording the signals produced for duration and amplitude.

This set of new model flight time mass spectrum pick up, collection, and analysis systems takes as its center a multipath duration amplitude recording device. It integrates a broad frequency band preamplifier, a high stability trigger device, and a Z8671 single chip device in its composition. Through a 232 standard port, it is connected to a Super AT machine that controls the entire experimental apparatus.

Multipath duration and amplitude recording devices are capable of recording six dispersed signals at a time. The time resolution is 5ns. The amplitude capability can handle 256 separate levels. Due to the fact that split phase methods are utilized, we made use of "off the shelf" low speed instruments and realized the objective of high speed time measurements. Moreover, we lowered the technical requirements of the wiring as a whole.

The preamplifier frequency band width is larger than 300MHz. The gain is greater than 40db. It can take a signal of only 1mv and amplify it to the point where it is large enough for the recording device input threshold value of 200mv. It guarantees that atomic probes, at relatively low voltages, also have single ion detection sensitivities. In conjunction with this, it reduces outside limit stray wave interference.

The trigger device is used in order to take the trigger pulse that is produced by the high voltage (laser) pulse and change it to a standard multipath time and amplitude recording device timing trigger pulse. Because of this, the required degree of stability is particularly high.

Z8671 single chip devices carry out program control for the multipath devices. Besides the transmission of numerical data, through A/D converter devices, measurements are made of the various power source voltages, and, by D/A, there is program control of the voltages of the various power sources.

Specialized use mass spectrum software principally has functions which include management (practical realization) of connection ports between Super AT machines and 8671 single chip devices, as well as their communication, data pick up and transfer. It principally has

functions such as data screening or debugging, data display, data storage, data analysis and processing, mass spectrum automatic identification, mass spectrum printouts, graphic diagram outputs, and other similar functions.

This type of new model flight time amplitude recording device obviously is capable of application to all the various types of analysis devices which require simultaneous and precise measurements of signal durations and amplitudes.

The Design and Manufacture of Several Key Component Parts in Comprehensive Electroemission Microanalysis Equipment

(Produced with Assistance from the National Education Commission Outstanding Young Teacher Fund)

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In order to take image forming atomic probes (IAP) and field electron radiation microscopes (FEM) and put them together, carrying out on the same sample research by different methods, it is necessary to test produce multifunction detectors. The reason for this is that one of the principal uses for FEM is to make precise measurements of power functions and the changes in them for the surfaces being studied. It follows from this that it is not possible to make use of channeling plates and other similar amplifying devices with gains that change with changes in the energies of particles being radiated in. Because of this, moreover, our designs make use of domestically produced channeling plate assemblies mounted with replacable type double channeling plate detectors. When the channeling plate is lined up with the florescent screen by the rotation of the vacuum shaft and locked down tight, it is possible to make it act as an FIM image magnification device, an AP ion detector device and operate as an IAP component selection imagery device. After it is turned on and grounded, the flouresent screen forms an FEM image, and, in conjunction with that, is connected to a field radiation electric current.

In order to raise the mass spectrum resolution of atomic probes, the flight distance design was 17cm. In this way, when the entire surface of the image formed had a mass spectrum done on it and was analyzed, we opted for the use of ϕ 70 planar passage or channel plates, and resolution rates were capable of reaching 1/50 amu. However, the image semiangle is only very slightly greater than 11 degrees. In order to make it convenient to observe and measure the entire surface of the sample, as well as to facilitate the selection of different crystal surfaces, we test manufactured a small and clever rotating structure for samples, making the angle for the entire image expand to 45 degrees. It not only makes the main vacuum chamber, when compared to opting for the use of "off the shelf" 5 dimensional rotation structures, have its very large volume reduce to a smaller size, but, moreover, its production costs are low. The sample loading or mounting frame that fits with this rotation structure is agile in its loading and unloading. Moreover, it is possible to apply heat to the samples. This very greatly expands the range of research subjects.

This comprehensive system is used primarily in order to do research on the entire surface of samples that can be seen. In order to strengthen the capabilities associated with research area range characteristics, between samples and detectors, there is an adjustable diameter detection aperture. Fitted to the sample rotation structure, is it not only capable of aiming at different crystal surfaces. Moreover, it is capable of altering aperture diameters to adjust analysis areas. Since this is the case, it makes the functions of this equipment even more multifarious.

General Electroemission Microanalysis Systems

(Produced with Assistance from the National Education Commission Outstanding Young Teacher Fund)

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Ever since Professor E.W.Muller invented the linear type high voltage atomic probe in 1967, this technology has gone through several improvements and has developed a great deal, turning into a powerful weapon in the research and analysis of solid body microscopic structures and microscopic components. At the present time, at various places in the world, operating atomic probe field ion microscopes have flight time focused high voltage pulse atomic probes (FTF HVP AP), image forming atomic probes (IAP), pulse laser atomic probes (PL AP) and linear type high voltage pulse atomic probes. However, this technology is still faced with a number problems of a basic nature, for example, in experimentation, strong exterior electric fields around samples. These have numerous and very significant ancillary effects on the results of experiments if one obtains three dimensional information from two dimensional FIM imagery. In order to obtain information to alter this situation, we test manufactured a brand new, comprehensive system for electroemissive or field effect radiation microscopic analysis.

This system, by a transformable detector, takes field electron radiaiton microscopes (FEM), field ion microscopes (FIM) and image forming atomic probes (IAP) and forms them into one entity. Besides being equipped with positive and negative direct current high voltage power sources, positive and negative high voltage pulse power sources, and pulse laser generartion devices, one also finds that there is an automatic mass spectrum data collector with a six path flight time

(resolution rate 5μs)--amplitude (256 level) recording unit controlled by a Z8671 single chip device. This imagery photograhic entry, digitization, display, and storage system is also composed of a high sensitivity LK-1002 Model CCD pick up head, as well as voltage measurement and detection system PIP-1024 image plate, Casper image display device and a data flow magnetic tape recorder. The various individual comprehensive systems are controlled by a Super AT microdevice in conjunction with which they carry out analysis and processing on data and imagery.

This comprehensive system not only possesses the various individual functions of FEM, FIM, and IAP. Moreover, it is capable of making use of its various types of different components to carry out work by synthesizing methods. Because of this, there are several brand new functions which await development. The most important is that this system is capable (unclear) of carrying out studies by different types of methods on the same sample. Because this is the case, it offers information from different methods on the different effects on experimental results.

This article intends to make a somewhat more detailed introduction of the special characteristics of this system and the good number of initial accomplishments which it has achieved.

General Electroemission Micronalysis Equipment Image Processing Systems

(Produced with Assistance from the National Education Commission Outstanding Young Teacher Fund)

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The field electron radiation microscope (FEM)--field ion radiation microscope (FIM)-- and image forming atomic probe (IAP) microscopic analysis systems which have been recently test manufactured have, as their objective, to research and analyze the surfaces of samples as well as their cubic microscopic structures and components. How to take the two dimensional images from FIM and extract three dimensional information forms the basic problem with realizing this goal. Because of this, we set up and, in conjunction, developed a special use imagery processing system which makes use of an FIM and IAP imagery input, imagery quality improvements, as well as special characteristic quantities to carry out structural studies.

This system is principally composed of high sensitivity cameras, imagery plates, and IBM-PC/AT microcomputers. In conjunction with this, it has such peripheral equipment as imagery display devices, digitizing instruments, data flow magnetic recording machines, as well as printer outputs, and other similar devices. The imagery plates are PIP-1024B, the degree of geometrical resolution is 512x51?. the grey or light level is 256 (8 bit), IMB imagery storage devi[illegible] capable of being directly connected with the main PC line, compl[illegible] imagery

storage and processing operations.

Aimed toward such aspects as the quality of FIM and IAP imagery and the special characteristics of structures, we set on foot an initial software development. Through the selection of different degrees of resolution (geometrical resolution), it is possible to obtain, in real time, multiple amplitude imagery. This is done to facilitate the analysis of sample surfaces in situations of rapid change. With respect to multiple amplitude continuously photographed imagery, we carried out synchronous superpositions, and it was possible to obtain clear imagery. We opted for the use of fixed time or manual methods. We were able to get imagery that recorded changes every second or longer period of time in order to do research on changes in slow processes. With respect to any composite of inputted imagery, we carried out Median, Sobel, Laplacian, Dilation, Erosion, and other similar kinds of wave filtering. It was possible to obtain a certain number of details. Making use of rat targets and machine specified atomic positions, we obtained geometrical characteristics and used them in imagery superposition and the extraction of three dimensional information, and so on and so forth. This article will provide a specific introduction to the initial effects obtained.

Vacuum Systems and Electrical Systems of General Electroemission Microanalysis Equipment

(Produced with Assistance from the National Education Commission Outstanding Young Teacher Fund)

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(China Scientific and Technical College)

Liu Limin Huang Guangming Chen Hongnian Liu Wu

(Huazhong Normal University)

This article introduces the most newly test produced field electron radiation microscope (FEM)--field ion radiation microscope (FIM)--and image forming atomic probes (IAP) microscopic analysis apparatus vacuum systems and the design and placement of electrical systems.

In order to satisfy the requirements of FEM operations, the main vacuum chamber degree of vacuum must be better than 10^{-7}(unclear) bars. Because of this, the vacuum system opts for the use of a dryable all stainless steel dual vacuum chamber structure which allows rapid sample exchanges. Moreover, when samples are exchanged, the main vacuum chamber need not be exposed to the atmosphere. The sample is still capable of going through many types of preprocessing in the prevacuum chamber.

The vacuum device set is composed of an aggregate of such oilless pumps as atomization (unclear) ion pumps and titanium sublimation pumps as well as such oil pumps as diffusion pumps and mechanical

pumps. Under normal conditions, only atomization (unclear) pumps and titanium (unclear) sublimation pumps are operated, avoiding oil contamination in the system. The pumps that have oil are only used in order to make vacuum system components that are exposed to the atmosphere return to a high vacuum as rapidly as possible. In this way, one not only guarantees the requirement for the non-oil super high vacuum, but also, lowers the expenses of creation and operation. In order to make the vacuum measurements reflect the vacuum environment of the samples, ionization standards are installed on the tail terminals in the vacuum chambers. In these systems, the degree of vacuum in the main vacuum chambers are as follows:

when only atomization (unclear) pumps are operating: a good 10^{-6}(unclear) Pa

after sublimation of the sublimation pumps: a good 10^{-7}(unclear) Pa

sublimation pumps with the addition of liquid nitrogen as a coolant: 8×10^{-9}(unclear) Pa

at the time of sample substitution: 10^{-4} Pa

This apparatus is also fitted to a quick connect gas supply system that can handle nine different gas bottles as well as with a small vacuum tank to process sample wires.

Besides the various vacuum pump power sources, this system is also fitted with various types of special use electric power sources. There are two positive 10kv direct current high voltage power sources which, respectively, supply the operating voltages for sample and imagery intensifiers or amplifiers. There is one negative 10kv direct current high voltage power source which supplies the voltage when doing FEM studies. Also, there is a high voltage pulse power source which has a maximum output of a positive 2kv, 4ns. When the system is operating in the HVP AP configuration, it supplies a field volatilization high voltage pulse. There is also a high voltage pulse power source with a maximum output of negative 2kv, 20ns. When one is selecting component imagery forms, it is used in order to activate the imagery intensifier or amplifier devices. All these power sources go through Z8671 single chip devices for measurement, readout, and program control.

The system as a whole is also fitted with a laser pulse operating

system composed of nitrogen atom laser devices, focus adjustment systems, and high speed photoelectric diodes. This makes the system as a whole capable of operating at will in either of the two different high voltage pulse or laser pulse configurations. This greatly expands the functions of this system.

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